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Contents:

(Illustrated articles are marked with an asterisk.)

PROFESSOR TYNDALL'S ADDRESS BEFORE THE BRITISH ASSOCIATION.

A most remarkable speech from a most remarkable man. Masterly in thought, profound in learning, keen in logic, it is startling in the boldness and vigor with which its author declares his faith in a materialistic doctrine and in the hardihood with which, asserting that forms of religious opinion have ever impeded Science, he claims for the latter unrestricted rights of research, while relegating the former to the sphere of the emotions. Such is Professor Tyndall's address delivered at the recent session of the British Association for the Advancement of Science at Belfast; and its utterances, if we mistake not, will arouse as acrimonious debate and call upon the head of the author as fierce denunciation as did the publication of his famous opinions on the "prayer gage." The time and place incident to the delivery of the discourse give to it additional weight; for in addition to its being the personal views to which he, as an eminent scientist, has been led by lifelong thought and study, it is an *ex cathedra* pronouncement of the President of the greatest and most influential of British scientific associations, which, unless distinctly repudiated, renders that body, in the eyes of the world at least, more or less responsible for its promulgation.

To understand the position which Professor Tyndall has taken in this sudden invasion of the neutral territory lying between scientific and religious thought, the reader finds himself called upon to reconcile views which at first sight appear at wide variance. "Abandoning all disguise," says the speaker, "the confession that I feel bound to make before you is that I prolong the vision backward across the boundary of the experimental evidence, and discern, in that Matter which we, in our ignorance, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of every form and quality of life."

This, standing alone, is unquestionably the most open materialism: but its force is modified when the assertion follows that "the whole process of evolution is the manifestation of a Power absolutely inscrutable to the intellect of man. As little in our day as in the days of Job can man by searching find this Power out. Considered fundamentally, it is by the operation of an insoluble mystery that life is evolved, species differentiated, and mind unfolded, from their prepotent elements in the immeasurable past. There is, you will observe, no very rank materialism here."

There is no negation of a creative power, while the affirmation of a sustaining cause repels the notion of atheism. The challenge is hurled at the theologians, the advocates of the science of divinity, and not the simply religious whose nature impels them to the belief in and leads them to love and reverence for their Creator.

Professor Tyndall demands for Science freedom of thought in every department of knowledge. He denies, in fact, the right of theology to compel us to accept in blind faith truths susceptible to the investigation of our own reasoning faculties.

In thus noting the views of a distinguished thinker, we chronicle an event of no common importance: albeit it is one of which the wisdom will be widely questioned, and the expedience (of directly bringing into popular controversy thoughts likely to disturb the faith of many) denied, even by believers. It must not be lost sight of that the large majority of people never think, but receive the faith of their ancestors unquestioningly; others are incapable of thinking for themselves, others too indolent and careless regarding the whole subject. These have regarded the agitations of the great theories of evolution and the like, which have deeply moved the scientific world, with indifference, and classed them with the older doctrines of Comte, Spinoza, and similar writers, which they abhor as atheistical and subversive of all religion and piety. On such people, the unmistakable utterances of Tyndall, dispersed broadcast by the public journals and not buried in technical publications, must have their effect; but whether the seed thus sown will fall on good ground and produce broader, wider ideas of the ineffable greatness of the Creator, or be choked by the tares of a belief undermined, resulting in skepticism and infidelity is a question which every individual must answer according to his own conscience.

A WOMAN WITHOUT BONES.

The social developments across the water show a lamentable state of affairs due apparently to no other cause than a deficiency of backbone in one or two individuals.

When such disastrous consequences proceed from the weakening of a part only of the human framework, we sincerely trust that there may be no spreading of the disease lately developed across the ocean in the person of an Irish woman, who lived to see her entire skeleton waste away until it was but a fourth part as heavy as a new born babe.

The case occurred in Dublin, and may truly be called extraordinary. The victim, forty-five years old, was a patient in an insane asylum. For five years she was confined to her bed, complaining of no pain, but gradually becoming weaker, while dwindling in stature until she lost half her hight.

As the disease progressed, her limbs were coiled up in every possible shape, the bones becoming extremely light, soft, fragile, and atrophied in every respect. At death, all that was left of her skeleton, including the skull, weighed two pounds and a half. The number of fractures was prodigious. The ribs were in a hundred fragments. The head of the humerus was bent; the fibulæ were curved; the thigh bones and pelvis were huddled together; the bones of the vertebræ were thinned and worn away across the front of their bodies; the lower jaw was atrophied and broken into three pieces; the base of the skull was cribiform all through. Had she lived a little longer, it was thought that not a vestige of a bone would have been left in her body. What ailed her no one could tell, the disease being almost unheard of and difficult to diagnose, treat, or even name. Professor R. W. Smith, of Dublin University, who brought the case before the Pathological Faculty, looked upon the condition of the bones not as a disease but as a manifestation of a diseased condition as yet unknown, possibly related to rickets.

LIVING BAROMETERS.

That is a curious instinct which a large number of animals possess, of predicting the weather and signifying the approaching change by peculiar movements or sounds. Some of their actions in this respect appear to be more governed by reason than by mere instinct, others are clearly due to the moisture in the air or various atmospheric influences, while some, which occur under conditions which prevent their being referred to the latter cause, offer an interesting field for the investigations of the naturalist. The presence of the barometer in almost every farmhouse, together with the weather bulletin or the dictum of "Old Probabilities," good for the next twenty-four hours, render such homely knowledge as that which governed the labors of the farmers and sailors of the last century almost superfluous in this advanced age; but the subject, like all topics which relate to the sagacity of the lower animals, is of itself an interesting one. And besides, it is not entirely impossible that some farmer to whom the barometer, if he had one, would be incomprehensible, and whose location prevents his obtaining the weather reports, may, by some odd action of his own cattle, of some insect, or of some bird, as described in the following lines, be forewarned of a coming storm in time, and save perhaps a crop during the present harvest months.

We have said that certain movements on the part of the animals, before a change of weather, appeared to indicate a reasoning faculty. Such seems to be the case with the common garden spider, which, on the approach of rainy or windy weather, will be found to shorten and strengthen the supporting guys of his web, lengthening the same when the storm is over. There is a popular superstition in England that it is unlucky for an angler to meet a single magpie; but two of the birds together are a good omen. The reason is that the birds foretell the coming of cold or stormy weather; and then, instead of their searching for food for their young in pairs, one will always remain on the nest. Sea gulls predict storms by assembling on the land, as they know that the rain will bring earthworms and larvæ to the surface. This, however, is merely a search for food, and is due to the same instinct which teaches the swallow to fly high in fine weather, and skim along the ground when foul is coming. They simply follow the flies and gnats which remain in the warm strata of the air. The different tribes of wading birds always migrate before rain, likewise to hunt for food.

There is a large variety of actions of which it is hardly possible to give a satisfactory explanation. Coming rain is foretold by the peacock uttering frequent cries, by the woodpecker lamenting, by parroquets babbling, by pintados perching, and by geese running around uneasily. So also it is said that, when a storm is at hand, swine will carry hay and straw to hiding places, oxen will lick themselves the wrong way of the hair, sheep will bleat and skip about, hogs turned out in the woods will come home grunting and squealing, colts will rub their backs against the ground, crows will gather in crowds, crickets will sing more loudly, flies come into the house, frogs croak and change color to a dingier hue, dogs eat grass, and rooks soar like hawks.

It is probable that many of these actions are due to actual uneasiness, similar to that which all who are troubled with corns or rheumatism experience before a storm, and are caused both by the variation in barometric pressure and the changes in the electrical condition of the atmosphere.

PLUMBERS' CARELESSNESS.

The Prince Consort of England was killed by typhoid fever generated by foul sewer gases, due to carelessness and ignorance in the plumbing work of his residence. The Prince of Wales nearly lost his life through the same insidious means, due to the same inexcusable cause. One of the grandest and most venerable of English cathedrals, that of Canterbury, was badly injured and nearly destroyed through sparks from a carelessly managed plumber's furnace igniting the roof. The magnificent Alexandra Palace, just completed and containing works of art of immense value, quite recently fell a victim to the flames, again originating among the plumber's working apparatus. Later still, the burning of the Liverpool landing stage, the greatest floating platform in the world, is now stated to have been due to the carelessness of the plumbers employed in joining the gas pipes below the flooring. The dangerous qualities of carelessness and ignorance, which are inherent to the workman of the trade, are therefore very justly coming in for their full share of reprobation from the English journals.

"Are we to spare a prince for every step of progress, or will our plumbers learn for the future without? They burn down cathedrals and music halls with unflinching impartiality by means of a system of soldering long ago abandoned by other nations. Thinking a good 'wiped joint' the perfection of human ambition, the plumber takes a long time over it and admires it lovingly from every side before he can make up his mind to part with it. This choice production of human skill is perhaps laid in the earth or built into a wall, and has no need of this fine art finish, but gets it, nevertheless." So says a correspondent of the English *Builder*. We echo his remarks with a grim sort of satisfaction, for it is not very long since we experienced one of the advantages of these lovely wiped joints, artistically molded by a bungler's paw. The completion of the work was the signal of a series of complaints (by the occupants of the building) that the water refused to run, except in a miserable little stream, from any of the faucets. Then we hired more plumbers to find out the mistakes of the first ones, and these overhauled pipes, and poked sticks and wires down them, and nosed around the cellar, and went on the roof, and ripped up the street. This was to the tune of something over a hundred dollars—still the water would not come; then the plumbers went at it again, and probably would have been struggling with wires and wrenches and spades and pincers up to the present time, had not some one suggested to look at the joints, and then the evil was found. One important wiped joint had had the solder squeezed into it so as to block up nearly the whole bore, and of course but very little water could pass through.

We hired another of the craft not long ago to look after a furnace, from every register of which horrible smells were emitted. We had a man and a helper; the duty of the latter was to hold a candle and converse with the man on appropriate and interesting topics, for which we paid him some dollars per day. This pair of worthies we turned loose in the house, with instructions to find out and eradicate the trouble. They got into the furnace, and poked brooms up into the flues, and took off the registers and poked brooms down. Then they pulled out several pieces of flue and soldered them over again, nobody ever could divine what for. Then they upset a furnace on a heap of kindling wood and nearly burnt the house down; and finally, after some days' tinkering, brought us an astonishing bill. We paid it, supposing that the work was thoroughly performed; but on lighting the furnace, again came the odor. On making a personal investigation, the first door that we opened (that in the brick casing of the furnace, which these individuals never thought to touch) revealed the cause in the shape of a bushel of dead rats. To make matters worse, the flues, which they had pulled out and fixed, had come to pieces, and we had to hire more plumbers to solder them with something besides rosin.

A few pages further on, in the same issue of the journal from which we clip the extract given in the beginning, is the report of the conflagration of some fine tenement houses in Edinburgh, due to a plumber's carelessness. The man left his furnace with a bright fire in it on the leads and went to dinner. A strong breeze blew it over, and the igniting of the building was the natural result.

We have no space to go over the series of outrageous botches which have been foisted upon us, coupled with enormous charges from plumbers, in this city. We have seen traps put in waterclosets, of not the slightest use in keeping down the noxious emanations. Water pipes run up the back walls instead of between the party walls, of course freezing at the first frost; new joints are made between floors, through which, the moment water was let on, the leakage poured out, to the ruin of our ceilings.

In fact so often have we been ruthlessly victimized that

when we do obtain a plumber that does his work in an honest, workmanlike, and substantial manner, at moderate cost, we shall be disposed to cherish him as a jewel of rare price.

QUICK AS WINK.

Our notions of the value of time are altogether relative. Ordinarily a minute more or less is a matter of little moment. A would-be passenger, who arrives at a railway station just in time to be too late, realizes that even a less interval than a minute may materially affect his calculations. To the timer of a closely contested race, a second is important; it may be a quarter of a second will make all the difference between fair speed and the "fastest on record." To the astronomical observer, a quarter of a second is a very long time, as an uncertainty of that amount might render worthless an observation which he can never hope to repeat, and for which he may have journeyed thousands of miles.

In some cases an interval so brief as that required for the movement which stands proverbially for instantaneous action may have a material effect on the accuracy of a calculation; indeed it is at times not only necessary to know and make allowance for the time of movements as quick as winking, but to know substantially how much quicker one man winks than another.

Though the movement of the eyelid is so rapid that there is no apparent interruption of vision, the act really involves half a dozen distinct physical and mental operations, the duration of each of which can be closely measured. If the movement is reflexive or involuntary, time is required for the transmission of the impelling sensation to the sensory center, time for its reflection to the winking muscle, time to overcome the inertia of the muscle—the period of latent excitation, as it is called—and lastly time for muscular contraction. That the sum of all these periods is something considerable can be roughly proved by counting the number of winks one can make in a second, or by timing the act by the ticking of a watch.

The purely reflexive part of the act of winking has been ingeniously timed by Dr. Sigismund Exner, who chose this act as the one best adapted to enable him to determine the time required for a complete reflex action. His apparatus consisted of a very light lever of straw, terminated at one end by a bristle which was applied to the eyelid, the other end being connected with the usual contrivance for exactly registering the beginning of muscular contraction. The stimulus was an electric spark, applied in two ways, by passing in front of the eye and thus acting on the optic nerve, or by exciting the nerve of sensation by striking directly on the cornea. He found the interval between the spark and the beginning of motion (that is, the time occupied in the transmission and reflection of the sensation, with the period of latent excitation in the muscle) to vary, with the intensity of the stimulus, from about $\frac{1}{18}$ to $\frac{1}{24}$ of a second, the stronger the spark the quicker the action. The period of latent excitation of muscle in man has never been precisely determined. Dr. Exner estimated it at about a hundredth part of a second, which would reduce the time required for the purely reflexive part of the act of winking to about $\frac{1}{2}\frac{1}{2}$ of a second for a weak impression, and $\frac{1}{2}\frac{1}{7}$ of a second for a stronger stimulus.

For a voluntary wink, a slightly longer time appears to be required, since a measurable interval is occupied in the act of volition.

WHAT MAKES THE APPLES ROT?

Our worst enemies are the smallest. All the ravenous beasts in the world, mad dogs included, probably destroy fewer human lives than are destroyed in this city alone by the ravages of those minute but virulent organisms of the genus *micrococcus*, to which we owe small pox, diphtheria, and some other malignant diseases. Simularly, the thousand sturdy weeds which annoy the farmer, the caterpillers and grasshoppers which occasionally devour his crops, are relatively innocent and harmless compared with the numerous microscopic pests which rust his grain, rot his potatoes and fruit, and otherwise levy their burdensome taxes without making themselves visible.

Just at this season, not the least interesting of these individually insignificant, collectively enormous, nuisances are the two forms of fungus growth which have most to do with the untimely destruction of fruit—*mucor mucedo* and *pencillium glaucum*.

Our apples decay, not because it is their nature to, as Watts might say, but because it is the nature of something else to seize on them for subsistence, as we do, at the same time making of them a *habitat*, as we do not. Kept to themselves, apples and other fruit never rot; they simply lose their juices by evaporation, shrivel, and become dry and hard, or, if kept from drying, remain substantially unchanged, as when securely canned. It is only when invaded by the organisms we have named that they lose color and quality, take on offensive tastes and odors, become covered with white or green mold—in short, develop rottenness and decay.

Formerly this process was thought to be no other than a continuation or exaggeration of the natural process of ripening, the chemical changes which produce the odor and flavor of the ripened fruit simply going on to their legitimate though less delightful end. But this theory overlooked the very common and important facts that fruit may rot without ripening, and that ripe fruit will not rot if properly protected.

It was not until the microscope was brought to bear on the problem, and the conditions of decay were so convincingly demonstrated, by Davaine, that the real nature of the process became clear. Now we know that, so far from being the complement of growth, the antithesis of life, decay is in reality the taking on of a more rapid though specifically different growth. It is synonymous not with death, but with intensely active life.

In general structure, the numerous microscopic fungi are very much alike, consisting mainly of a network of colorless cells and filaments, called the *mycelium*. This is the vegetative part. There is, besides, a reproductive part, in which is produced the seed or "spore," the structure of which is different in the different genera. In the mucor each reproductive filament bears a globular swelling at its superior extremity, in the interior of which the spores are developed. In the pencillium glaucum the reproductive filament bears a tuft of from four to eight branches, which, in turn, produce upon their extremities a chaplet of small oval spores. It is called *pencillium* on account of this pencil-like tuft of its spore-bearing filaments, and *glaucum* from their bluish green tint. The mold so frequently seen in oranges is produced by this fungus. It is comparatively of slow growth, and the alteration it produces in the properties of the fruit it lives in and upon is not so marked as that caused by the mucor.

When a fruit is invaded by either of these fungi, the vegetative filaments send their branches among and around the fruit cells, and rapidly envelop them in a network of mycelium, absorbing the substance and juice of the fruit, and producing the chemical transformation characteristic of decay. All this goes on in the interior of the fruit, the fructification of the fungus taking place only on the surface, in contact with the atmosphere. For this reason fruit covered with a firm, fine skin, like the apple, may be a mass of what we call corruption within—in other words, thoroughly decomposed by fungus growth—while no visible mold—the fructifying part—appears on the surface. On the other hand, thin-skinned fruits like the strawberry, which are easily pierced by the reproductive filaments, are often covered with an abundant fructification in a very short time, for the fecundity of these microscopic fungi is sometimes as marvelous as the rapidity of their growth. For example: A single zöospore of the *peronospora infestans*, which causes the potato rot, will envelop the cellular tissue of a potato leaf with mycelium filaments in twelve hours, and fructification will be completed in eighteen hours longer. One square line of the under surface of a leaf, where the fructification naturally takes place, may bear as many as three thousand spores. Each spore supplies half a dozen zöospores, individually capable of originating a new mycelium. From one square line, therefore, there may come, in less than two days, nearly twenty thousand reproductive bodies, and a square inch may yield nearly three millions! No wonder the disease spreads rapidly.

In the case of fruit, decay may be originated in two ways, and two only: by direct contagion or by wind-wafted spores. With firm-skinned fruit like apples, still another condition is essential, namely, a break in the skin of the fruit to allow the parasite to enter and take possession. In every case of decay in apples, the center of disturbance will be found at a bruise, scratch, or puncture; and unless such a way be opened, the apple may hang until it is dry as leather, or it may lie for weeks in direct contact with rottenness, and remain perfectly sound.

To this it may be objected that the constant presence of the fungus in decay is no proof that it is the cause of that condition, on the contrary, the breaking down of the fruit tissue by violence, and subsequent chemical action owing to access of air, may rather make the growth of the fungus possible by preparing a suitable soil for its development. The objection has been met in the investigations of Davaine. The evidence that the fungus precedes and causes the changes which we call decay is of the same character as that which establishes the connection between a vaccine pustule and inoculation by vaccine virus. When sound fruit is inoculated with the spores of pencillium, decay begins at and spreads from the point of inoculation. Apples similarly wounded, but not inoculated, remain the same.

FAT IN FORAGE PLANTS.

To any one not a chemist or a quadruped, the last place to look for fat would be a hay mow or a stack of straw; yet it appears from recent investigations that fat is not only an essential constituent of hay, straw, and similar forms of vegetation, but one of considerable economic value.

In the lower leaves of oats in blossom, Arndt found as much as ten per cent of the dry weight to consist of fat and wax, the latter appearing as the bluish bloom so conspicuous on the leaves of luxuriant cereals. In fodder crops, generally the greatest proportion of fat is found in young and thrifty plants. Thus Way found early meadow grass to contain as much as six and a half per cent of fat; while in that of the same meadow, collected in the latter part of June, there was but a little more than two per cent. The proportion of fat is increased by nitrogenous manures: the grass of a sewaged meadow at Rugby contained above four per cent of fat, while similar grass, not sewaged, afforded less than three per cent of fat.

The nature of this sort of vegetable fat was investigated some little time ago by the German chemist König, who found that by treatment with strong alcohol the fat of grass and clover hay could be separated into two parts, one a solid waxy substance, the other a fluid fat, soluble in alcohol. At first he considered the latter to be a true glycerin, but changed his mind after the investigations of Schulz, who proved that, though it contains the same proportion of carbon and hydrogen as ordinary fat, the fluid fat of hay is something quite different, since no glycerin can be obtained from it.

König has since confirmed these results and carried forward the investigation, showing that the fat of oats, rye, and vetch seed is similarly constituted. In all these forms of vegetation, hay, oat straw, the grain of oats, rye, vetches, and possibly others, he finds oleic and palmitic acids, not combined with glycerin but in a free state; and as these acids in their combinations are well known as large ingredients of nutritive fats and oils, it is likely that they have a considerable influence on the value of these plants for fodder.

König also finds in hay and in oat straw the important ingredient of animal bile, *cholesterin*; still further, cerotic acid, a waxy body which forms twenty-two per cent of ordinary beeswax; and two fatty substances new to Science, one fluid, the other solid. They are distinct compounds, having the character of fatty alcohols. Another interesting discovery in hay fat is the presence of a hydrocarbon, the relations of which are not fully made out. In several respects, it agrees with some of the paraffins.

SCIENTIFIC AND PRACTICAL INFORMATION.

EFFECTIVE POWER OF ANCIENT WEAPONS.

A curious and interesting series of experiments recently took place in France, under the auspices of the Directors of the Museum of St. Germain, which consisted in tests upon ancient war engines constructed after the basreliefs found on Trajan's column.

An onager—variety of catapult—threw stone balls to a distance of 640 feet. Bolts from another kind of catapult traveled 960 feet in six seconds of time, showing a velocity of projection of 160 feet per second. The range and adjustment of the engines were readily calculated, and accurate shots were made at a distance of 480 feet. It would seem therefore that ancient Roman artillery included weapons of by no means contemptible effect, particularly since the muskets of seventy years ago failed to carry with accuracy over a distance equal to but little more than half that last mentioned.

NEW PROCESS FOR MAKING SILVERED TELESCOPIC MIRRORS.

M. A. Nicole states that he has succeeded in producing telescopic reflecting mirrors cheaply and easily by the electroplating process. He takes the mold of a concave surface, made of a mixture which is either an electrical conductor itself or else a non-conductor metallized by the aid of nitrate of silver and phosphorus dissolved in sulphide of carbon. In either case the mold is plunged in a bath of galvanic silver, where the current, conducted very slowly to the mold determines a deposit of excellent quality.

When the silver has reached a thickness of 0·015 inch, the bath of that metal is replaced by one of copper, so as to obtain a solid backing. The mold is then dissolved or melted and the mirror removed, nothing further being necessary than a light polishing. M. Nicole adds that he has produced perfect mirrors of four inches in diameter in this manner.

COMBUSTION OF POWDER.

As the result of their extended series of experiments, details of which we have from time to time published, Messrs. Noble and Abel conclude that the explosion of gunpowder determines a temperature of 4664° Fah., comparable to that of the fusion of platinum. The products of the explosion consist in 57 per cent of solid matters and 43 per cent of permanent gases, the latter consisting of carbonic acid, nitrogen, carbonic oxide, and sulphuretted hydrogen. Small grained powders give less gas than those of large grains: but generally the variations are so great that it is impossible to express the reaction by any chemical formula. The solid matters are mainly carbonate, sulphate, and hyposulphite of potash.

MUSCARINE.

This is the poisonous principle extracted from a mushroom of the genus *agaricus*. According to Dr. Prevost, of Geneva, when it is administered in a very weak dose it acts with force upon the pancreatic and biliary, while lessening the urinary, secretions. It is known that the sulphate of atropine produces exactly the contrary effects, so that these two poisonous substances are therefore antidotes to each other.

PARAFFINIC ACID.

Submitted to the action of fuming nitric acid at 47° B., or to that of a mixture of sulphuric acid and fuming nitric acid, paraffin oxidizes and becomes transformed into an oily liquid, of a light yellowish green color, which M. Champion has named paraffinic acid, and to which he ascribes the formula $C^{26}H^{26}N\,O^{10}$.

The composition of the paraffinic acid permits paraffin to to be certainly designated by the formula $C^{48}H^{50}$. It may therefore be regarded as a clearly defined compound, and not as a mixture of different carburets of hydrogen.

ACTION OF ATMOSPHERIC VAPOR ON THE LUMINOUS AND OBSCURE HEAT OF SOLAR RAYS.

Father Provenzali, as the result of investigations on the above subject, finds that the luminous heat and the obscure heat do not maintain a constant relation, but that, while the former diminishes, the latter increases, and *vice versa*. The luminous heat diminishes in proportion as the quantity of vapor in the atmosphere augments. Such is not the case with obscure heat; for during days of the greatest absolute humidity, the obscure rays are almost always the strongest. This is ascribed to the radiating power of the aqueous vapor, which, after having absorbed the luminous rays, emits them under the form of obscure heat.

The conclusion reached is that photometric observations, continued over a long period, may be a useful means of determining the hygrometric state of the superior regions of the atmosphere.